TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDIX A
SIMULATION RESULTS IN SUPPORT OF THE OU 3-14 FEASIBILITY STUDY

Annette Schafer and Pete Martian

A-1 PURPOSE AND OVERVIEW

The purpose of this appendix is to present the results of the Waste Area Group 3, Operable Unit 3-14 (WAG-3, OU 3-14) groundwater pathway simulations in support of the feasibility study. Simulations were performed evaluating the effect of several different remedial options including: (1) removing 50% of the anthropogenic water, (2) preventing infiltration from the Big Lost River near the Idaho Nuclear Technology and Engineering Center (INTEC), (3) eliminating infiltration through the area surrounding the tank farm, (4) immobilizing Sr-90 remaining in the alluvium, and (5) complete remediation of the Snake River Plain Aquifer (SRPA) by pumping water from the aquifer.

The sources of Sr-90 included in this evaluation consist of the: tank farm sources (18,100 Ci), OU 3-13 soil sources (918 Ci), CPP-02 abandoned french drain (33.8 Ci), CPP-3 injection well failure (8.0 Ci), and percolation ponds (0.3 Ci). In addition, 16 Ci of Sr-90 were injected directly into the aquifer in well CPP-03 as service waste. The primary sources of Sr-90 in the tank farm were associated with Sites CPP-31 (15,900 Ci), and CPP-79 deep (874 Ci). Current Sr-90 found in the aquifer is thought to originate primarily from the discharge of service waste in CPP-03, and from rapid transport of Sr-90 originating in CPP-79 and CPP-31.

In order to quantitatively assess the evolution of Sr-90 as it was transported through the alluvium, into and through the vadose zone, and its subsequent migration in the aquifer, a series of models were used. Of these different models, a traditional advective-dispersive multiphase transport simulation approach was adopted to represent the transport from Sites CPP-79, CPP-03 (and its failure), CPP-02, the percolation ponds, and the OU 3-13 soil sources. For these sites, the model used is described in detail in Appendix A of the remedial investigation/baseline risk assessment (RI/BRA) [DOE-NE-ID 2006]. A more detailed geochemical approach was taken to represent the release of very high ionic strength sodium bearing waste that occurred at Site CPP-31. In 1972, 15,900 Ci of Sr-90 were released into the surficial alluvial material along with 18,600 gal of sodium-bearing waste. This highly acidic, very high ionic strength sodium bearing waste from the concentrate of the Process Equipment Waste Evaporator is responsible for the majority of contaminants currently in the alluvium and underlying vadose zone at INTEC. The justification for the comprehensive hydrogeochemical simulation approach was presented in Sections J-1 through J-7 of the RI/BRA [DOE-NE-ID 2006]. The resultant predictive model for Sr-90 was evaluated for hydrogeochemical parameter sensitivity and comparisons to field data were summarized in Sections J-9 through J-13 [DOE-NE-ID 2006].

Simulations in support of this feasibility study are perturbations of the RI/BRA base model discussed in Section 8 of the RI/BRA [DOE-NE-ID 2006]. The RI/BRA base model was parameterized using a cation exchange capacity (CEC) for the alluvium equal to 2 meq/100 g, an interbed K_d=50 mL/g, 18 cm/yr infiltration from precipitation, and anthropogenic water discharges distributed throughout INTEC. At INTEC, a majority of the Sr-90 was released at Site CPP-31. Based on results obtained using the geochemical model for the CPP-31 release, within the first 20 years, 12,336 Ci of Sr-90 from Site CPP-31 were predicted to pass from the alluvium into the first basalt unit under the alluvium. The 3,564 Ci of Sr-90 that remained in the alluvium 20 years after the Site CPP-31 release were distributed vertically in the alluvium corresponding to the measured soil concentrations as an adsorbed source with an alluvium K_d of 2 mL/g. Smaller Sr-90 releases at land surface were accounted for by placing them at their representative locations in the alluvium with a K_d of 20 mL/g. Sr-90 introduced into the aquifer and deep vadose zone through the CPP-03 injection well was also placed into the model at the appropriate time and location. With these parameters, the predicted peak aquifer concentration in year 2095 is 18.6 pCi/L, which does not fall below the MCL of 8 pCi/L until year 2129.

OU 3-14 is specifically tasked with ensuring that Sr-90 concentrations in the Snake River Plain Aquifer (SRPA) do not exceed the MCL in or beyond year 2095. In order to accomplish this, the time-rate of arrival of Sr-90 from the vadose zone added to existing Sr-90 concentrations in the aquifer must be less than the rate of natural attenuation in the aquifer. Natural attenuation mechanisms include dilution, dispersion, and decay. The Sr-90 existing in the aquifer is primarily a remnant of that introduced through the use of the CPP-03 injection well. This includes Sr-90 that was injected directly over a 200 ft completion interval, and Sr-90 introduced into the deep vadose zone during times of casing failure. Additional Sr-90 is predicted to arrive at the vadose zone-aquifer interface from land surface sources, with first appearances having been predicted to have already occurred at low concentrations. Peak fluxes from the land surface sources are predicted to occur well after the current time, and depending on the scenario evaluated, continue to occur for decades. In order of decreasing activity, the majority of the Sr-90 currently in the vadose zone is 1) in the sedimentary interbeds as an adsorbed phase, 2) at very high concentrations in the perched water in and above the sedimentary interbeds, and 3) remaining in the alluvial sediments.

Controlling releases from the perched water and, by implication, from the sedimentary interbeds is the responsibility of OU 3-13 Group 4. Potential activities of OU 3-13 Group 4 were not taken credit for in the RI/BRA base model but are evaluated here because of their influence on predicted Sr-90 concentrations in the SRPA. Simulations specifically addressing potential OU 3-13 Group 4 activities include those remedies in which recharge to the perched water bodies underlying INTEC is controlled. The primary actions evaluated here are described below in order of appearance:

1. <u>50% reduction in anthropogenic recharge</u>. The first simulation presented here evaluates the relative importance of controlling anthropogenic recharge. It assumes that 50% of the anthropogenic water can be removed by the year 2008. Anthropogenic water losses incorporated in the RI/BRA model are shown in Table A-5-5 and Figure A-5-6 of the RI/BRA [DOE-NE-ID 2006]. They are assumed to be distributed throughout INTEC with the primary losses near the tank farm attributed to the fire water system. Fire water infiltration amounts to roughly 4 cm/yr. Reducing infiltration rates will slow the downward migration of Sr-90 while it is in the vadose zone, allowing more radioactive decay to occur en route to the SRPA.

2. <u>Preventing recharge from the Big Lost River</u>. The second simulation evaluates the impact of preventing recharge from the Big Lost River. In all of the simulations presented in the RI/BRA for Sr-90, the influx of water from the Big Lost River allowed rapid downward migration of Sr-90 from more-contaminated regions of the vadose zone. In general, the Big Lost River is a source of perched water body recharge, with more of this recharge occurring below the 110-ft interbed. This section begins with an analysis of the region of the vadose zone impacted by the Big Lost River (Section A-3-1). As a result of this analysis, fluxes are removed only in the effective middle reach of the Big Lost River beginning in year 2010. Reducing infiltration from the Big Lost River will reduce recharge to the perched water zones, will reduce flux rates through the perched zones, and will allow more radioactive decay to occur prior to reaching the SRPA.

3. <u>Immobilizing Sr-90 in the alluvium</u>. The third simulation is provided to assess the specific OU 3-14 option of immobilizing the Sr-90 thought to remain in the alluvium at Site CPP-31. This is assumed to occur in year 2008 by source removal or other in situ means while maintaining the same infiltration rate through the tank farm soil. This will not allow additional Sr-90 to migrate downward from the contaminated soil, while preserving the time required to reach the aquifer from the perched water. It will not affect travel times for Sr-90 currently in the perched water. The specific mechanism of immobilization is not evaluated here, and it is assumed that the mechanism would not reduce infiltration through the contaminated area.

4. <u>Reducing infiltration in the 10-acres surrounding the tank farm</u>. The fourth simulation assesses the effect of reducing infiltration through the area adjacent to the tank farm and through contaminated tank farm soil. In an area 200 X 200 m containing the tank farm, fluxes are reduced to 0.1 cm/yr. The area initially contains 18 cm/yr precipitation infiltration in addition to 4 cm/yr fire water losses. We assume that the flux will be reduced to 0.1 cm/yr in 2012. Reducing the infiltration in this area will affect infiltration rates through the highest-concentration regions in the perched water and will

increase travel times en route to the SRPA. Reducing infiltration to 0.1 cm/yr is consistent with an infiltration-reducing cap covering an area of roughly 10 acres.

5. Removing Sr-90 from the SRPA via pump and treat. Simulation five assumes that the OU 3-13 Group 4 activities will be ineffective and that remediation of the aquifer will be necessary. In this simulation, the pumping rates and durations required to lower concentrations to the MCL everywhere in the SRPA for the entire time period during which the MCL is predicted to be exceeded are evaluated.

Additional options were evaluated using combinations of Actions 1-4 above as indicated in Table A-1-1. Combinations of the alternatives are also shown in Table A-1-2, and the parameters altered from the RI/BRA base case are summarized in Table A-1-3.

Feasibility Simulation	Section
Reducing anthropogenic water recharge by 50%	A-2
Preventing infiltration from the Big Lost River	A-3
Immobilizing Sr-90 in the tank farm alluvium	A-4
Reducing infiltration through the 10 acres surrounding the tank farm	A-5
Preventing infiltration from the Big Lost River and reducing anthropogenic water recharge by 50%	A-6
Reducing anthropogenic water recharge by 50% and reducing infiltration through the 10 acres surrounding the tank farm	A-7
Preventing infiltration from the Big Lost River and reducing infiltration through the 10 acres surrounding the tank farm	A-8
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50%, and reducing infiltration through the 10 acres surrounding the tank farm	A-9
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50%, and immobilizing Sr-90 in the tank farm alluvium	A-10
Aquifer pump and treat for complete remediation	A-11

Table A-1-1. Summary of areas and times affected for FS simulations.

.

Simulation	Reducing anthropogenic water recharge by 50%	Preventing infiltration from the Big Lost River	Reducing infiltration through the 10 Acres surrounding the tank farm	Immobilizing Sr-90 in the tank farm Alluvium
Reducing anthropogenic water recharge by 50%				
Preventing infiltration from the Big Lost River				
Reducing infiltration through the 10 acres surrounding the tank farm				
Immobilizing Sr-90 in the tank farm alluvium				
Preventing infiltration from the Big Lost River and reducing anthropogenic water recharge by 50%				
Reducing anthropogenic water recharge by 50% and reducing infiltration through the 10 acres surrounding the tank farm				
Preventing infiltration from the Big Lost River and reducing infiltration through the 10 acres surrounding the tank farm				
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50%, and reducing infiltration through the 10 acres surrounding the tank farm				
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50% and immobilizing Sr-90 in the tank farm alluvium				
Aquifer pump and treat for complete remediation				

Table A-1-2. Summary list of simulations conducted in support of the OU 3-14 remedial investigation/baseline risk assessment/feasibility study (RI/BRA/FS).

Feasibility Simulation	Section	Precipitation recharge in the 10 Acres (200 X 200 m) surrounding the tank farm (10^6 gal/year)	Alluvium K_d (mL/g)	Big Lost River infiltration central reach (10^6 gal/year)	Anthropogenic infiltration across INTEC (10^6 gal/year)	Aquifer pumping rate (10^6 gal/year)
RI/BRA model assumptions		1.9	2	119	9.97 (4 cm/yr from fire water in the tank farm = 0.42 Mgal/yr in 10 acres)	None
Reducing anthropogenic water recharge	A-2	1.9	2	119	4.98 after 2008	None
Preventing infiltration from the Big Lost River	A-3	1.9	2	0. after 2010	9.97	None
Immobilizing Sr-90 in the alluvium	A-4	1.9	100,000 after 2008	119	9.97	None
Reducing infiltration through the 10 acres surrounding the tank farm	A-5	0.01 after 2012	2	119	9.97	None
Preventing infiltration from the Big Lost River and reducing anthropogenic water recharge by 50%	A-6	1.9	2	0. after 2010	4.98 after 2008	None
Reducing anthropogenic water recharge by 50%, and reducing infiltration through the 10 acres surrounding the tank farm	A-7	0.01 after 2012			4.98 after 2008	
Preventing infiltration from the Big Lost River, and reducing infiltration through the 10 acres surrounding the tank farm	A-8	1.9	2	0. after 2010	9.97	None
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50%, and reducing infiltration through the 10 acres surrounding the tank farm	A-9	0.01 after 2012	2	0. after 2010	4.98 after 2008	None
Preventing infiltration from the Big Lost River, reducing anthropogenic water recharge by 50%, and immobilizing Sr-90 in the tank farm alluvium	A-10	1.9	100,000 after 2008	0. after 2010	4.98 after 2008	None
Aquifer pump and treat for complete remediation	A-11	1.9	2	119	9.97	289.1 (2077–2102) 96.2 (2102–2123)

Table A-1-3. Parameters altered from the base case in the feasibility simulations.

A-2 REDUCING ANTHROPOGENIC WATER RECHARGE BY 50%

The purpose of this simulation was to determine the effect of reducing facility water discharges by 50% in year 2008. Anthropogenic water discharge rates assumed in the RI/BRA base model are a result of leaks in the water distribution system, lawn irrigation, and from sanitary sewers, etc. There are ongoing efforts to remove unused water supply lines, increased restrictions on intentional water discharges, and other actions being implemented to reduce these discharges.

In the RI/BRA model the simulated infiltration rate was spatially varying across the INTEC with an average value excluding the Big Lost River and former percolation ponds of 29 cm/yr being applied through year 2095. Averaged across INTEC, this total includes approximately 11 cm/yr of anthropogenic water (i.e., lawn irrigation, steam vents, line leaks, etc.) and 18 cm/yr of precipitation infiltration. The volumetric total of all anthropogenic water was estimated at 10 Mgal/yr. When known, anthropogenic losses were applied at representative locations (i.e., lawn irrigation areas or sanitary sewer systems (septic tanks) not using the central sewage treatment lagoon). Other losses (water supply losses and fire suppression line leaks) have not been attributed to specific locations and the resultant recharge was uniformly distributed across the entire INTEC facility as shown in Table A-5-5 and Figure A-5-6 of the RI/BRA [DOE-NE-ID 2006]. In the 200 X 200 m area near the tank farm, the anthropogenic losses total 4 cm/yr or 0.42 Mgal/yr.

In this simulation, we assumed that 50% of all anthropogenic water losses could be eliminated in year 2008 and that all of the anthropogenic water losses are eliminated in year 2095 and beyond. This 50% reduction was applied to each of the anthropogenic water sources in the model. Reducing the surface infiltration rate will result in (a) slower migration through the aquifer; (b) increased residence time for Sr-90 in the vadose zone allowing for more decay to occur en route to the aquifer; (c) reduced lateral and longitudinal dispersion along the flow path, potentially increasing vadose zone concentrations while reducing the areal extent; and d) decreased dilution. Because this water source is fairly uniform at land surface, the competing effects will occur equally in northern and southern INTEC.

A-2-1 Vadose Zone Sr-90 Simulation Results

The predicted distribution of Sr-90 in the vadose zone through year 2293 is shown in Figure A-2-1 through A-2-2, and can be compared to Figures J-8-10 through J-8-13 (RI/BRA). Peak vadose zone concentrations are given by the red line in Figure A-2-3 and can be compared directly to the RI/BRA base case (black).

In the vadose zone, the peak concentrations after removing 50% of the anthropogenic water are nearly identical to the peak concentrations in the RI/BRA base case. This equality is largely due to the peak vadose zone concentrations representing the pore water of the alluvium, which is readily apparent in the results shown in Section A-4. For the purposes of supporting future decisions, a better performance measure might be the time-evolution of concentration in each perched water zone.

In the RI/BRA base model and in this model, it was assumed that most of the anthropogenic water is distributed throughout INTEC as opposed to being focused in northern INTEC. This results in a total of 18 cm/yr of precipitation infiltration and 4 cm/yr anthropogenic water entering through the tank farm. As shown by the contours of Sr-90 concentration in the vertical plain, infiltration is primarily downward, with relatively little lateral spreading. As illustrated by horizontal and vertical contours, the highest concentrations reside directly beneath the tank farm area. By allowing continued infiltration from precipitation through the high concentrations directly under the tank farm, reducing anthropogenic water by 50% results in 20 cm/yr infiltration compared to 22 cm/yr in the base case. This allows a relatively small decrease in the flux rate of Sr-90 entering the aquifer as shown in Figure A-2-4. In Figure A-2-4, the rate at which Sr-90 enters the aquifer from the vadose zone is represented by the red line, which can be compared to the RI/BRA base case flux shown in black. Prior to year 2008, the fluxes applied in the RI/BRA base model and in this model are identical. Between years 2008 and 2095, reducing the anthropogenic water losses results in a slight decrease in the flux entering the aquifer. Following the complete removal of anthropogenic water in 2095, the rate at which these flux rates converge is quite rapid.

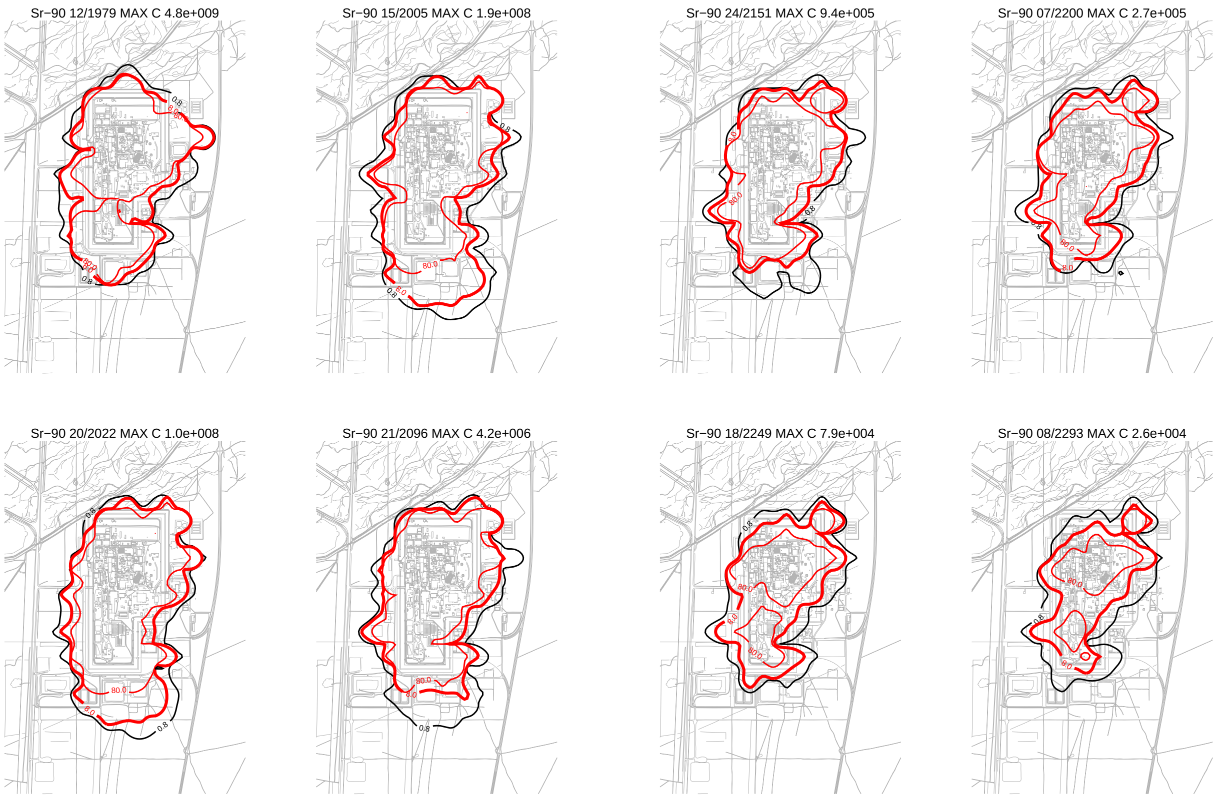


Figure A-2-1. Vadose zone concentrations (pCi/L) as (horizontal contours) after removing 50% of the anthropogenic water (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

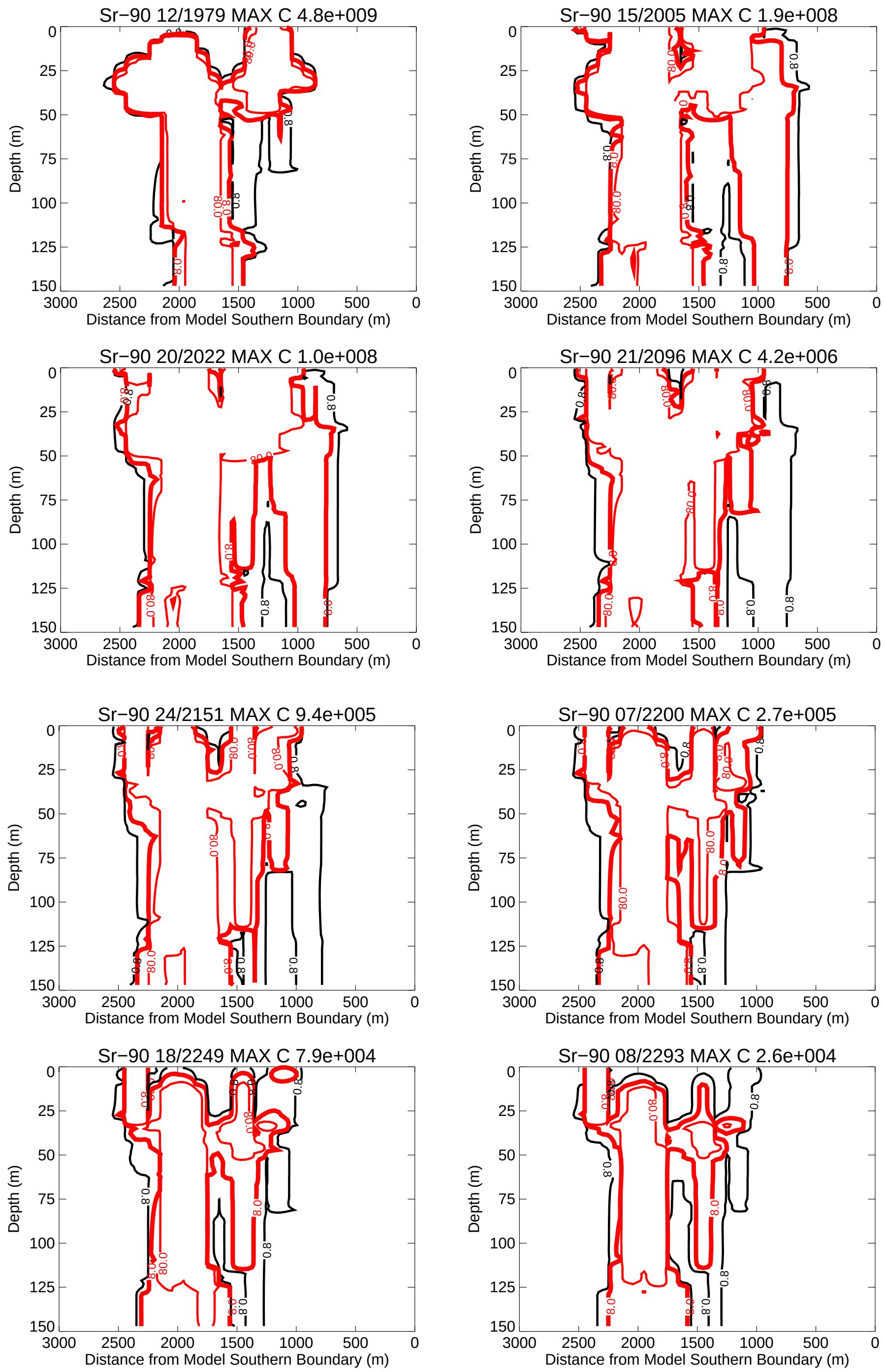


Figure A-2-2. Vadose zone concentrations (pCi/L) (vertical contours) after removing 50% of the anthropogenic water (continued) (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

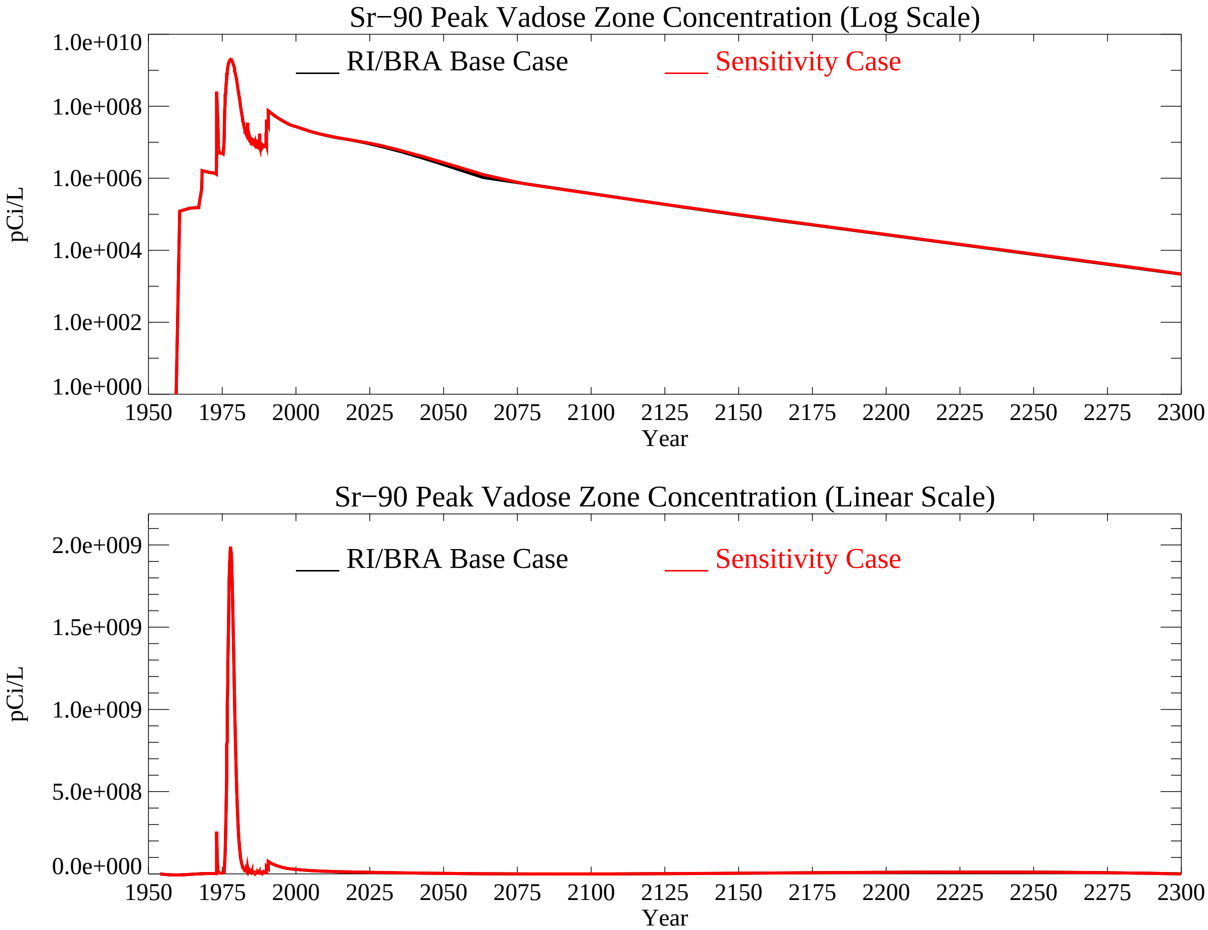
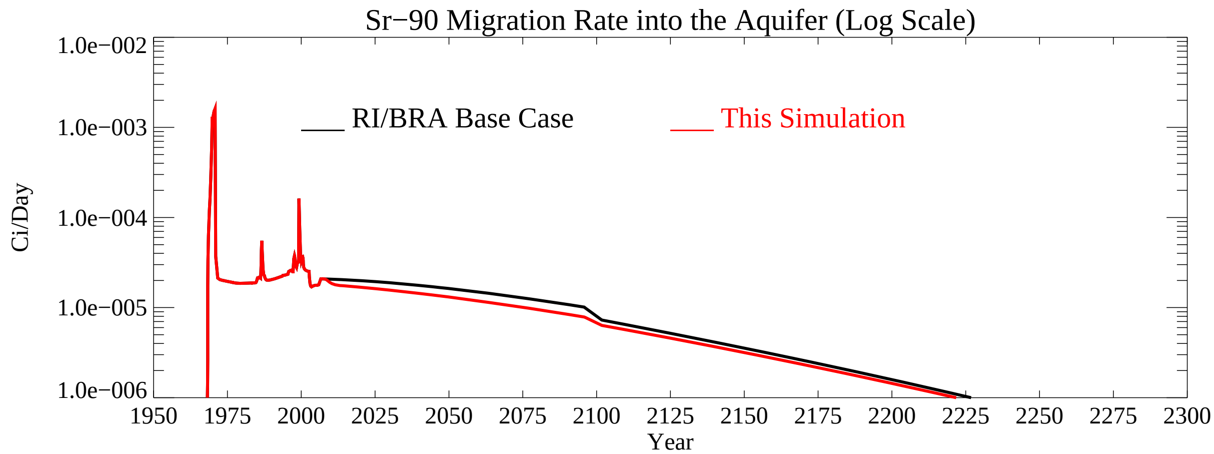


Figure A-2-3. Peak vadose zone concentrations (pCi/L) after removing 50% of the anthropogenic water (model predicted = black line [base case] and red line [this case]).



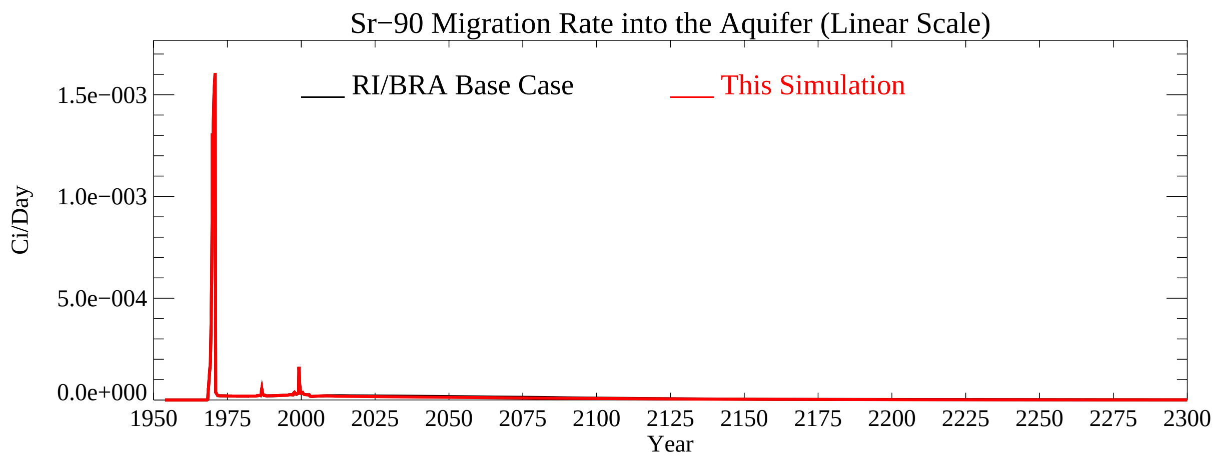


Figure A-2-4. Activity flux into the aquifer after removing 50% of the anthropogenic water (Ci/day) (model predicted = black line [base case] and red line [this case].

A-2-2 Aquifer Sr-90 Simulation Results

Predicted Sr-90 concentrations in the aquifer through year 2096 on the course grid are shown in Figure A-2-5 and through the year 2151 on the fine grid in Figure A-2-6. These can be compared to the RI/BRA base case results shown in Figures J-8-18 and J-8-19 (RI/BRA). The three performance measures considered are (1) the peak concentration in year 2095, (2) year the concentrations fall below the MCL everywhere in the aquifer, and (3) areal extent of concentrations above the MCL through time.

Resultant peak aquifer concentrations after removing 50% of the anthropogenic water are represented by the red line in Figure A-2-7 and can be compared directly to the RI/BRA base case results shown in black. As expected from the activity flux arriving in the aquifer from the vadose zone, the predicted peak aquifer concentrations in both cases are very similar. Prior to year 2008, the concentrations are identical; there is a slight decrease in predicted concentrations in the 2008-2095 time period, after which the concentrations are again nearly equal. Prior to year 2008, the fluxes from the vadose zone are identical, they differ by removing 50% of the anthropogenic water throughout the 2008-2095 time period, and return to equal values after 2095. The later time coincides with the complete removal of anthropogenic water in both simulations.The peak aquifer Sr-90 concentration after removing 50% of the anthropogenic water was predicted to be 14.4 pCi/L in year 2095 compared to the 18.6 pCi/L predicted in the RI/BRA base case.

Sr-90 concentrations after infiltration reduction are predicted to remain above the MCL through year 2122. In the RI/BRA base case, they were predicted to fall below the MCL in year 2129. Because of the wide distribution of anthropogenic water, removing 50% of it allows concentrations to drop to 8.0 pCi/L only 7 years earlier than predicted for the RI/BRA base case.

In year 2049, the area contaminated above the MCL is slightly narrower than predicted in the base case. Through year 2096, the area has diminished somewhat relative to the RI/BRA base case, but the north-south dimension is roughly the same. In year 2151, the area contaminated by the 8.0 pCi/L levels are nearly identical relative to the RI/BRA base case. Reducing infiltration water throughout INTEC has very little effect on lateral dispersion. As a result, Sr-90 that has already been laterally distributed in the vadose zone continues to move vertically downward. Reducing this uniformly distributed water source does not have a large effect in the north because of the relatively small flux rates compared to the Big Lost River.

It is important to note that in Appendix J of the RI/BRA [DOE-NE-ID 2006], it was determined that the distribution and amount of anthropogenic water is one of the most sensitive parameters. If the anthropogenic water losses are either higher than assumed in the RI/BRA base case or if more of the assumed losses are focused in northern INTEC (see the RI/BRA Section J-11.3, DOE-NE-ID 2006), removing 50% of the anthropogenic water would result in significant decreases in predicted fluxes entering the aquifer. Under these two conditions, removing a northern water source could greatly reduce aquifer concentrations in 2095 while reducing the areal extent.

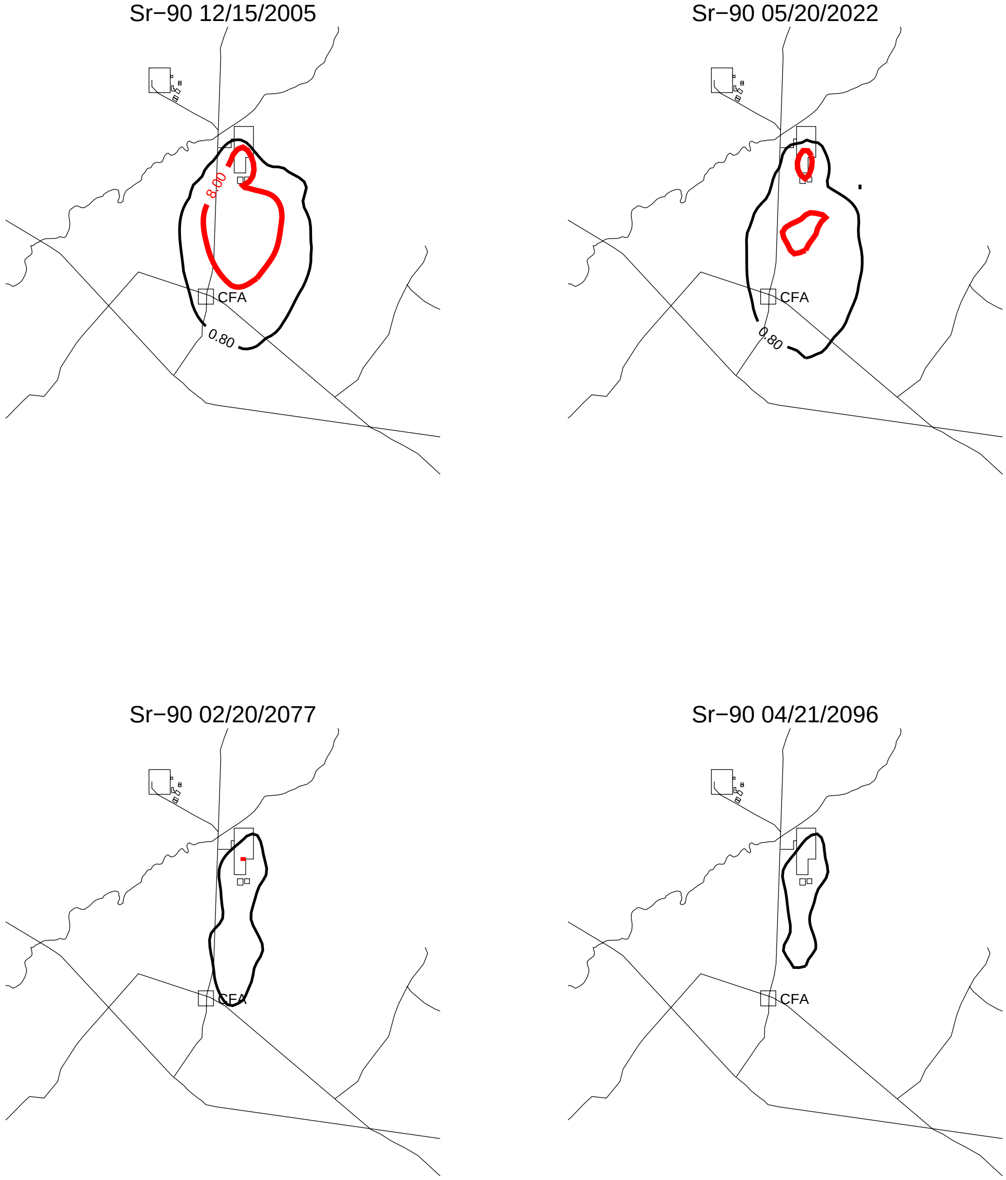


Figure A-2-5. Aquifer concentrations (horizontal contours) (pCi/L) after removing 50% of the anthropogenic water (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

Figure A-2-6. Aquifer concentrations (horizontal contours) (pCi/L) after removing 50% of the anthropogeni water (continued) (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

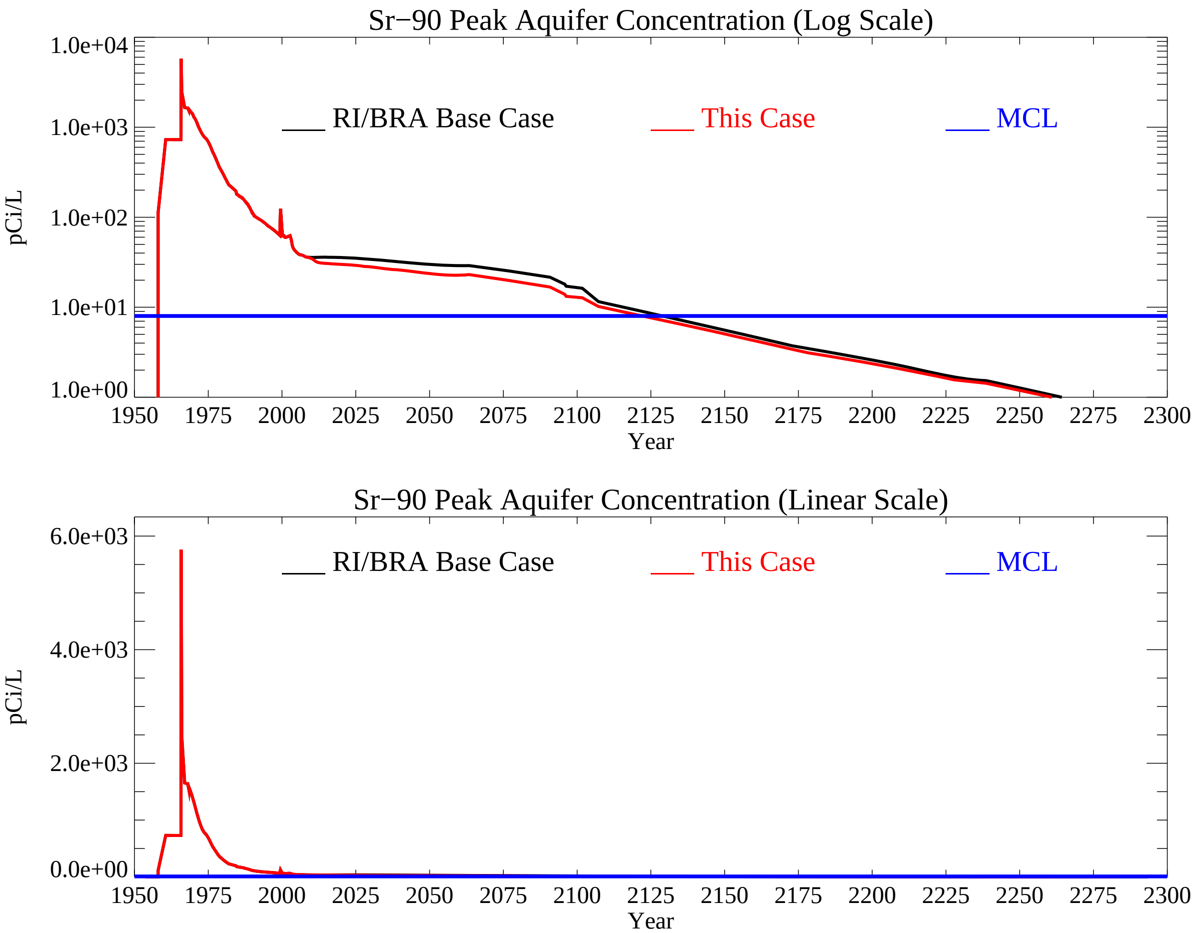


Figure A-2-7. Peak aquifer concentrations (pCi/L) after removing 50% of the anthropogenic water (MCL = blue line, model predicted = black line [base case] and red line [this case]).

A-3 PREVENTING INFILTRATION FROM THE BIG LOST RIVER

The purpose of this simulation was to determine the effect of preventing recharge from the Big Lost River between the years 2010 and 2095. The Big Lost River is one of the primary sources of northern perched water recharge as suggested by the sensitivity and RI/BRA simulations. In those simulations, the Big Lost River has a large impact on contaminant movement deep in the northern INTEC vadose zone. The sensitivity simulations suggest that recharge from the Big Lost River to the shallow vadose zone is minimal and that the river does not reach the 110-ft interbed beneath the tank farm. However, within and below the 140-ft interbed, the Big Lost River does appear to recharge perched water beneath the tank farm. The horizontal area impacted increases with depth, as the water spreads laterally along sloping interbeds and, in all simulations, rapid increases in Big Lost River fluxes are responsible for rapid migration of deep contaminants into the aquifer.

In the RI/BRA model, the Big Lost River fluxes were accounted for using a transient infiltration history up through year 2000. During the 2000-2004 time period, corresponding to the recent hydrologic drought, these fluxes were set to zero. After year 2005, and through the end of the simulation period, the Big Lost River was assumed to flow at the long-term average rate. In this simulation, we assume that infiltration from the Big Lost River can be stopped in year 2010 and that it is allowed to flow after year 2095 at the long-term average rate.

A-3-1 Determining the Area of the Vadose Zone Impacted by the Big Lost River

Below, we identify the river reach contributing to significant recharge in the northern perched water during the period (1999) of peak flow in the Big Lost River. This allows estimating the necessary diversionary measures required to minimize the contribution of the river to perched water recharge. As a first estimate, the length of Big Lost River crossing the vadose zone model was divided evenly into a west, middle, and east reach. Recharge in each reach was simulated simultaneously using three different water components with a separate component used in each of the three reaches. The simulation was started from the steady-state condition established in year 1954, and the time slice corresponding to year 1999 was chosen to represent the peak flow in the Big Lost River. The results shown here are derived after long-term transient flows in the Big Lost River. As a result, following drought conditions, the extent impacted by the Big Lost River will be less than shown.

The model grid blocks used to represent the west, middle, and east reach are illustrated in Figure A-3-1 as red, blue, and yellow regions, with the fraction of pore water originating from each reach shown in Figures A-3-2, A-3-3, and A-3-4 for each reach. It is clear that water from the east and west reaches does not spread far enough to impact the tank farm region. Further, water from the east and west portions of the Big Lost River does not appear to contact regions contaminated by high concentrations of Sr-90. Thus, in the simulation that follows, we assume that they are not significant recharge sources for the northern perched water underlying INTEC. On the other hand, the middle reach contributes 25% to 75% of the pore water at the 25- to 60-m depth interval in northern INTEC. In this depth interval, the recharge from the Big Lost River is confined mostly north of the tank farm and is quite extensive to the northeast. The north-sloping 110-ft interbed tends to keep the recharge from reaching to the southeast at that elevation, while the south-dipping 140-ft interbed allows more migration toward the tank farm. Currently, the highest observed concentrations are in the 110-ft interbed.

In the 60- to 100-m depth interval, the area impacted by the middle reach of the Big Lost River at 0-50% of the pore water is about the same as that for the 25- to 60-m depth interval as indicated by the similar positions of the 0.25 and 0.5 isopleths. However, the 75% isopeleth is slightly further north of the tank farm in the northeast at the 60- to 100-m interval. In the 100- to 140-m depth interval, the relative contribution to pore water at the 25% level extends under the tank farm and to the southeast of the tank farm, showing extensive impact at depth.

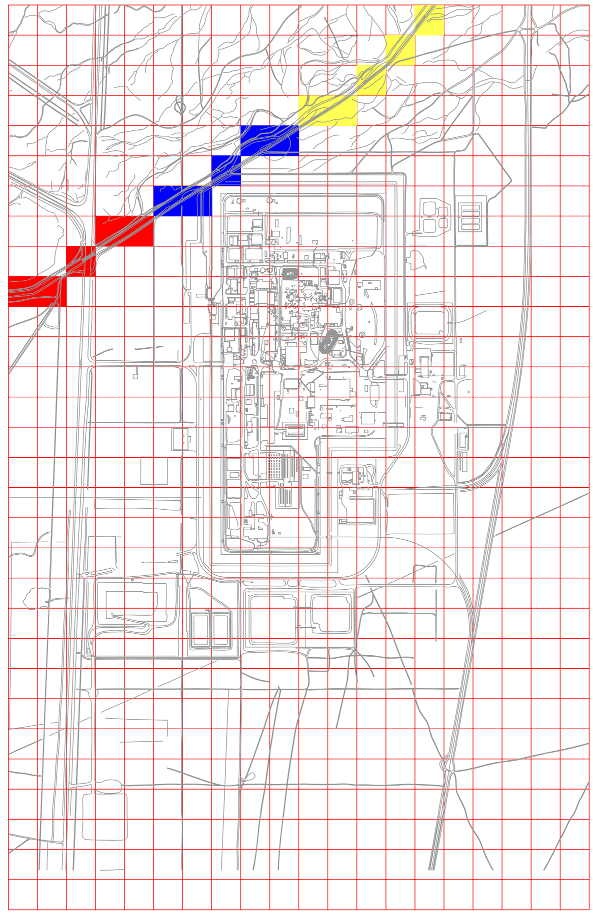


Figure A-3-1. Regions of the Big Lost River delineated as the west, middle, and east reaches represented as red, blue, and yellow, respectively.

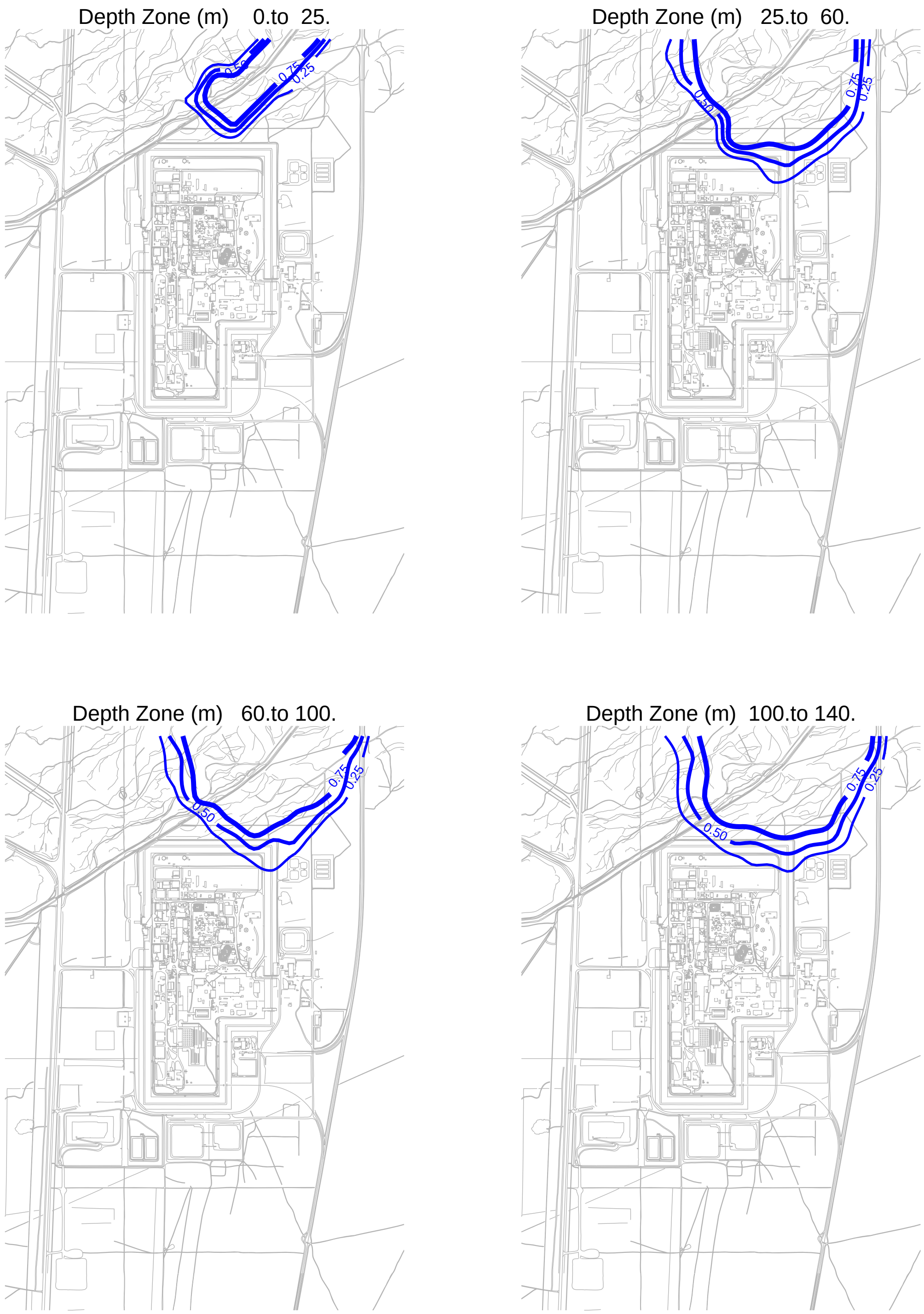


Figure A-3-2. Subsurface pore water fraction originating from the east reach of the Big Lost River.

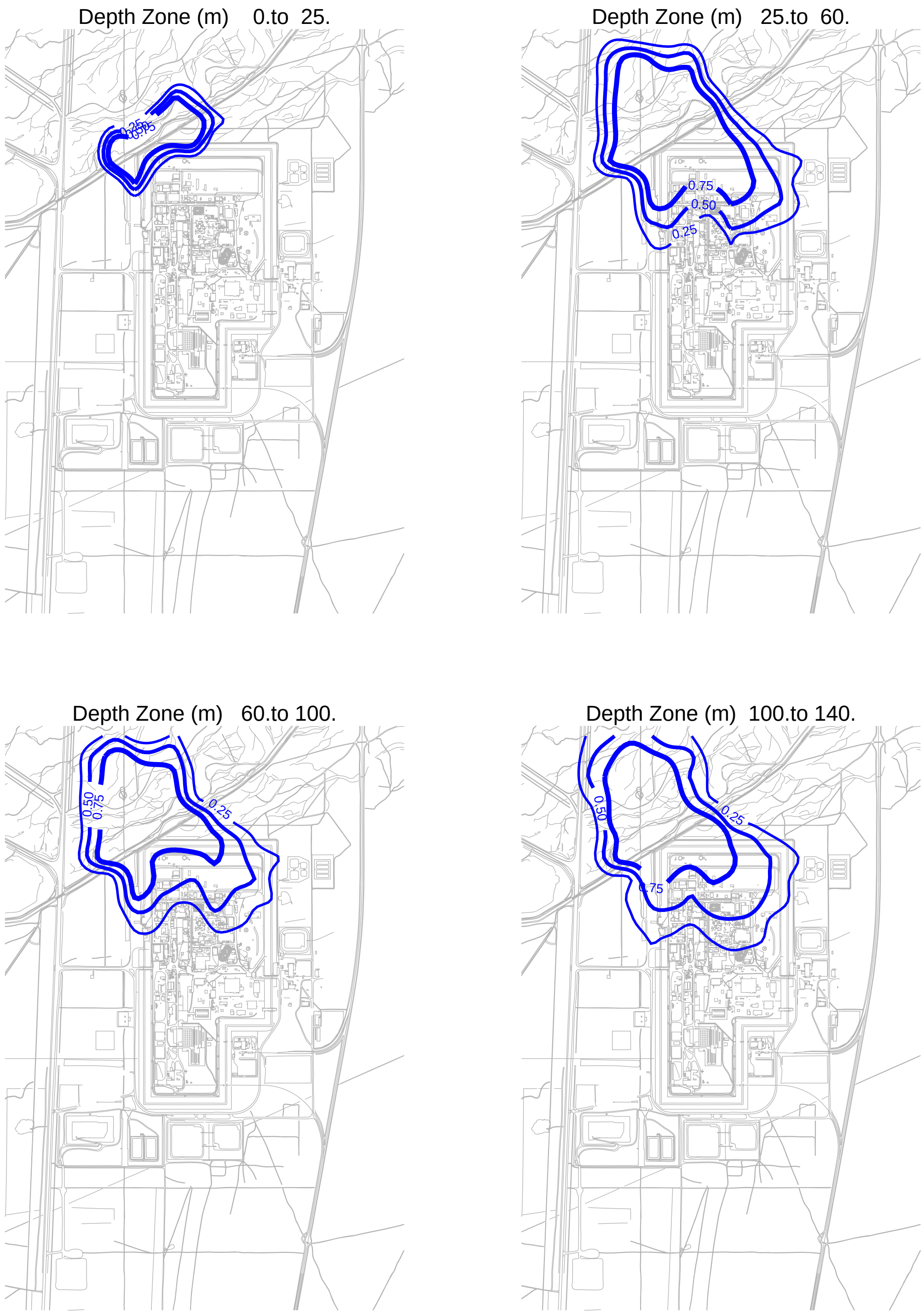


Figure A-3-3. Subsurface pore water fraction originating from the middle reach of the Big Lost River.

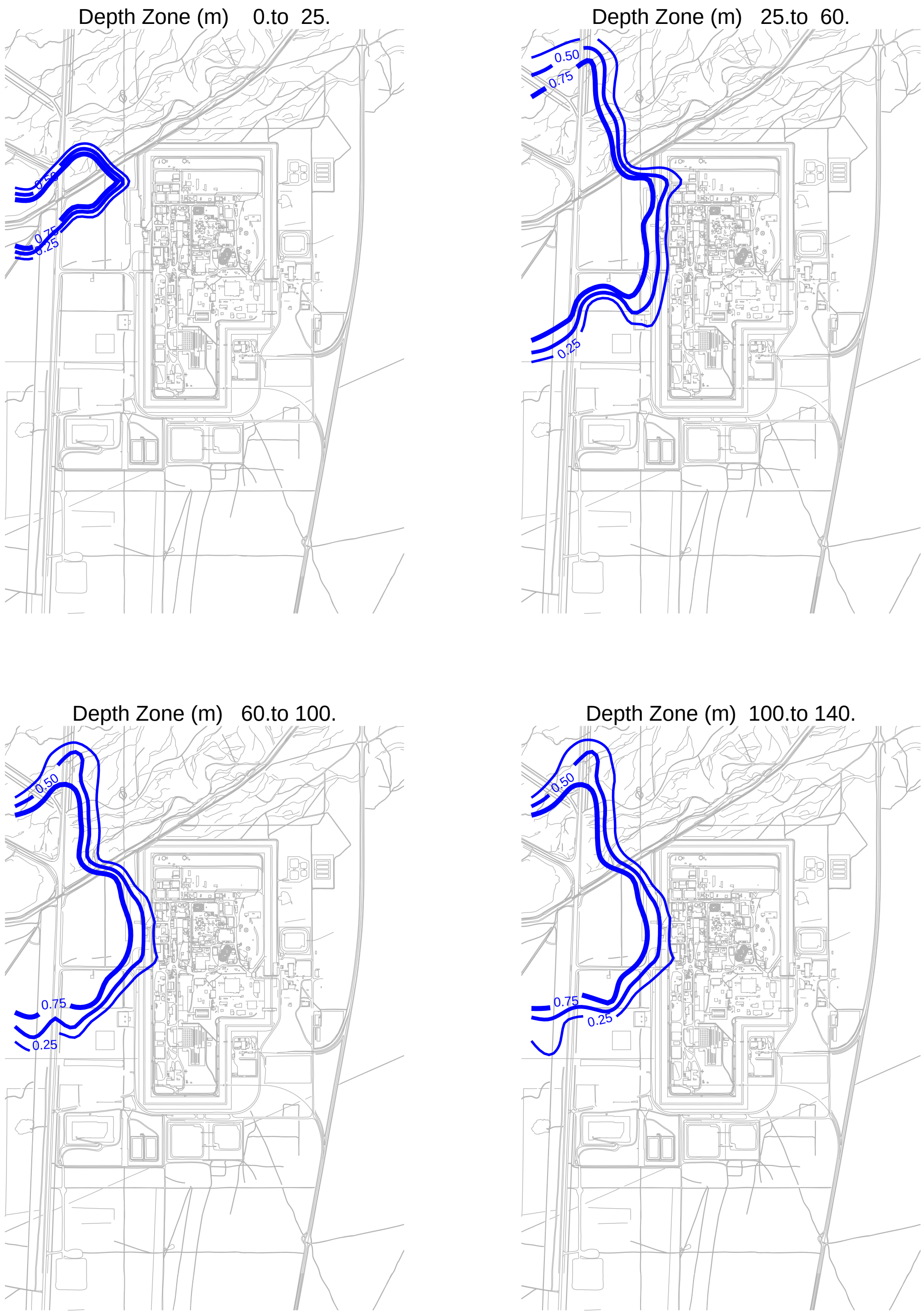


Figure A-3-4. Subsurface pore water fraction originating from the west reach of the Big Lost River.

A-3-2 Vadose Zone Sr-90 Simulation Results

As determined in Section A-3-1, the middle reach of the Big Lost River accounts for a significant portion of the pore water in the vicinity of the tank farm. The following simulation results remove this infiltration beginning in year 2010 and continuing throughout the duration of the simulation. Reducing the infiltration from the Big Lost River will result in (a) decreased dilution of Sr-90; (b) slower migration from the vadose zone while en route to the aquifer; (c) increased residence time for Sr-90 in the vadose zone, allowing for more decay to occur en route to the aquifer; and (d) reduced lateral and longitudinal dispersion along the flow path potentially increasing vadose zone concentrations while reducing the areal extent. These competing effects will primarily affect transport below the 140-ft interbed in northern INTEC.

Figures A-3-5 and A-3-6 illustrate the distribution of Sr-90 in the vadose zone through the year 2293 for comparison to the RI/BRA base case results shown in Figures J-8-10 through J-8-13 [DOE-NE-ID 2006]. These concentration profiles are not significantly different at the 80- and 8-pCi/L levels. There are subtle differences at the 0.8-pCi/L isopeleth, with those differences occurring very near the Big Lost River.

Peak vadose zone concentrations after removing infiltration from the Big Lost River are shown in red in Figure A-3-7. In comparison to the RI/BRA base case, shown in black, there are no significant differences. This is consistent with the previous simulation, and, as shown in Section A-4, the highest vadose zone pore water concentrations are in the alluvium and are not affected by water recharge from the Big Lost River.

The migration rate out of the lower vadose zone is slightly affected by reducing the Big Lost River infiltration (red line) as shown in Figure A-3-8. Compared to the RI/BRA base case, shown in black, these differences occur immediately after removing the Big Lost River infiltration in year 2010. By year 2095, fluxes have been reduced by a factor of two, and remain roughly half as high as the RI/BRA base case through year 2180. In year 2095, both cases reflect the complete removal of anthropogenic water. In comparison to the RI/BRA results, removing this relatively large volumetric infiltration in northern INTEC only results in a difference of 1.52 Ci of Sr-90 entering the aquifer.

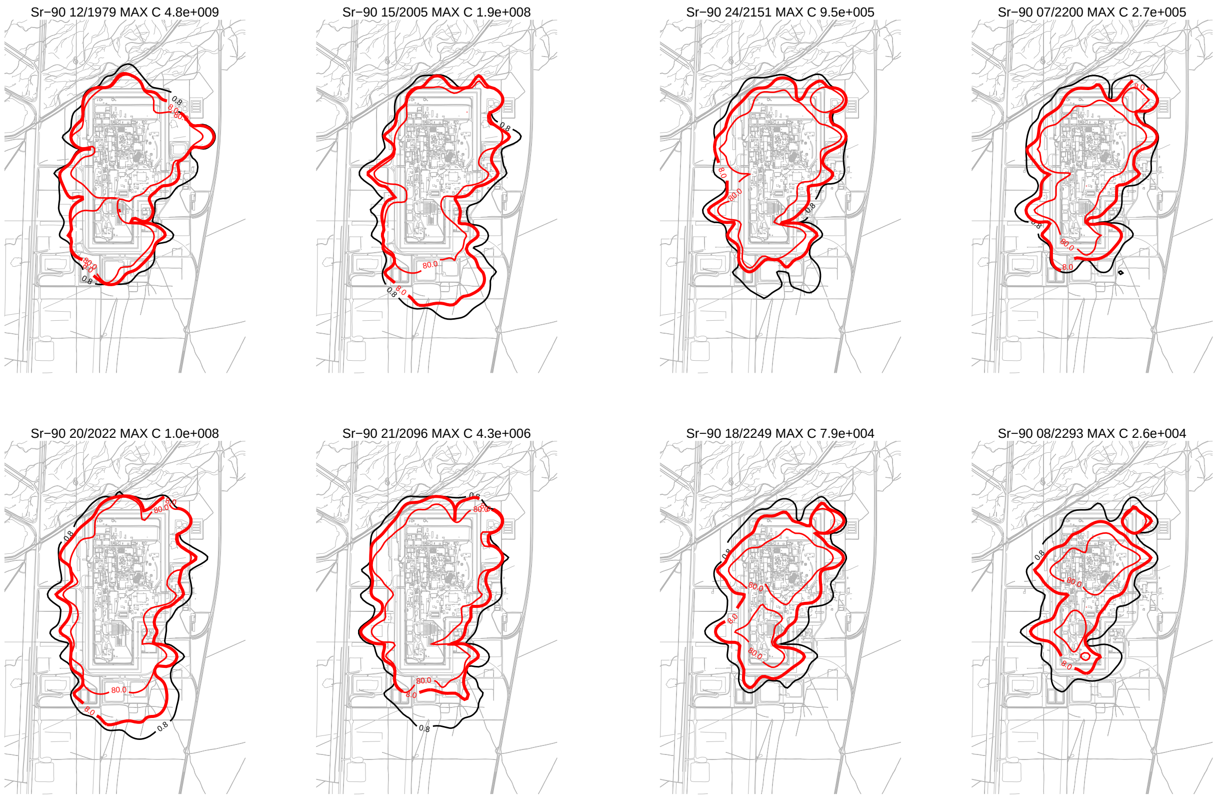


Figure A-3-5. Vadose zone concentrations (horizontal contours) after preventing infiltration from the Big Lost River (pCi/L) (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

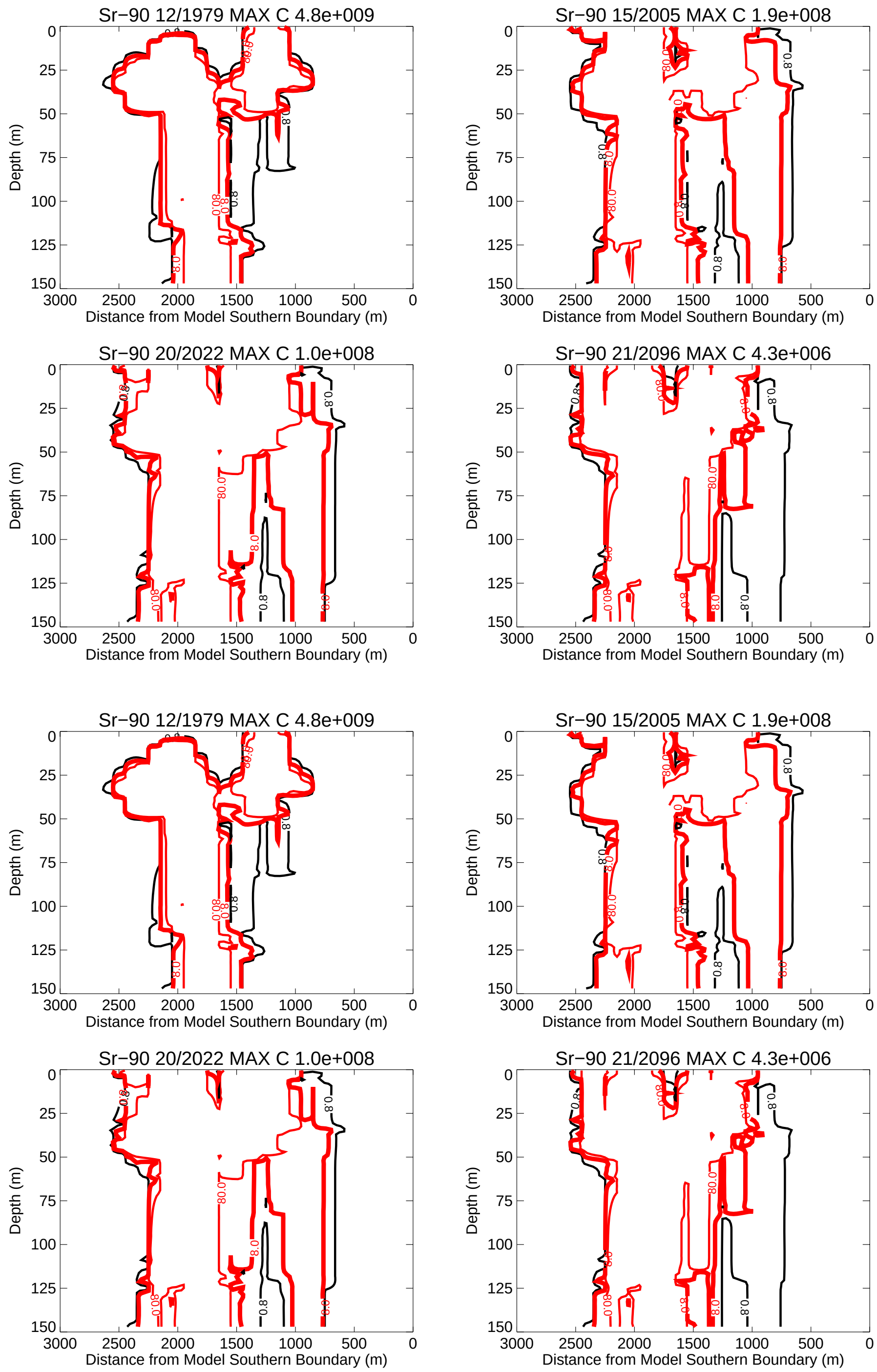


Figure A-3-6. Vadose zone concentrations (pCi/L) (vertical contours) after preventing infiltration from the Big Lost River (MCL = thick red line, 10*MCL=thin red line, MCL/10 = black line).

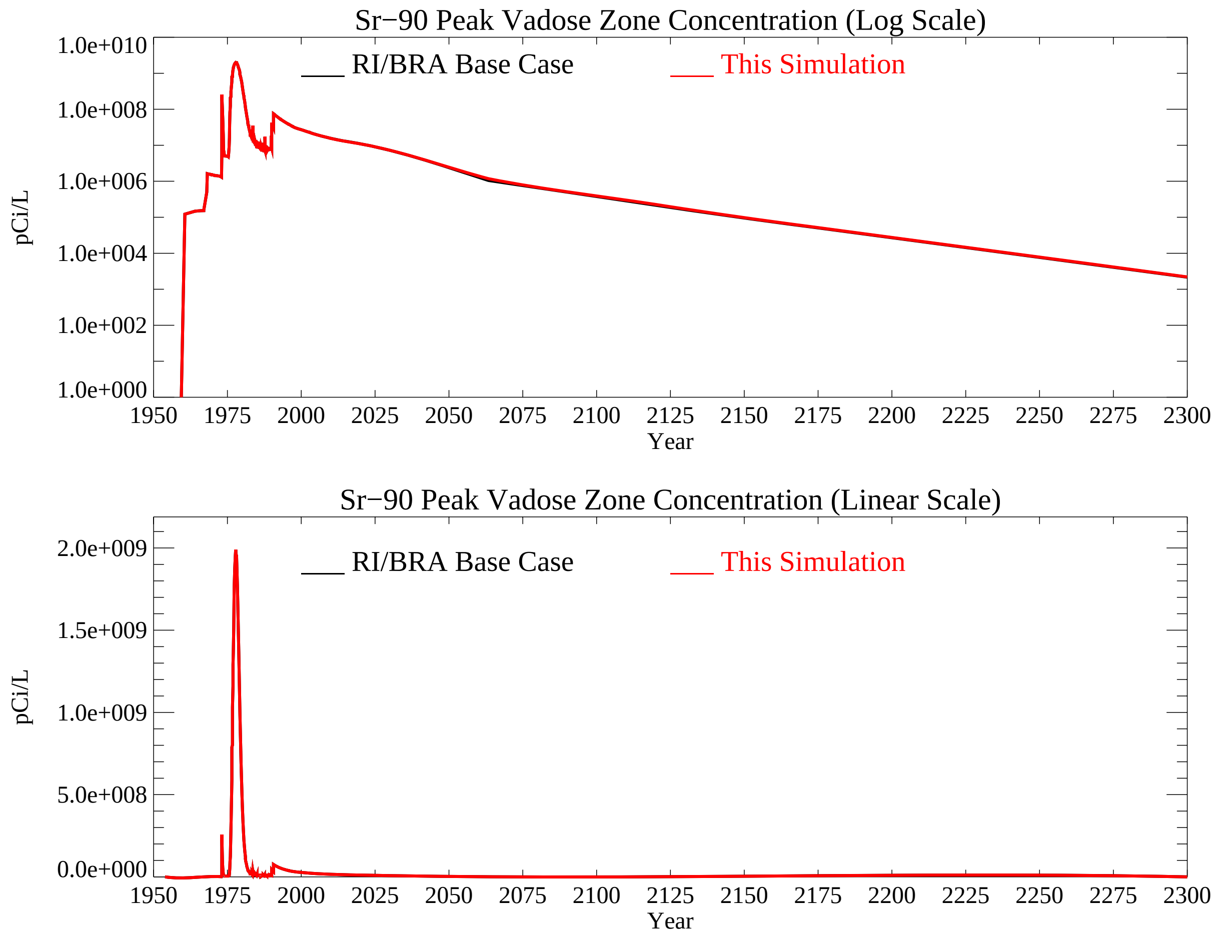


Figure A-3-7. Peak vadose zone concentrations (pCi/L) after preventing infiltration from the Big Lost River (MCL = blue line, model predicted = black line [base case] and red line [this case]).

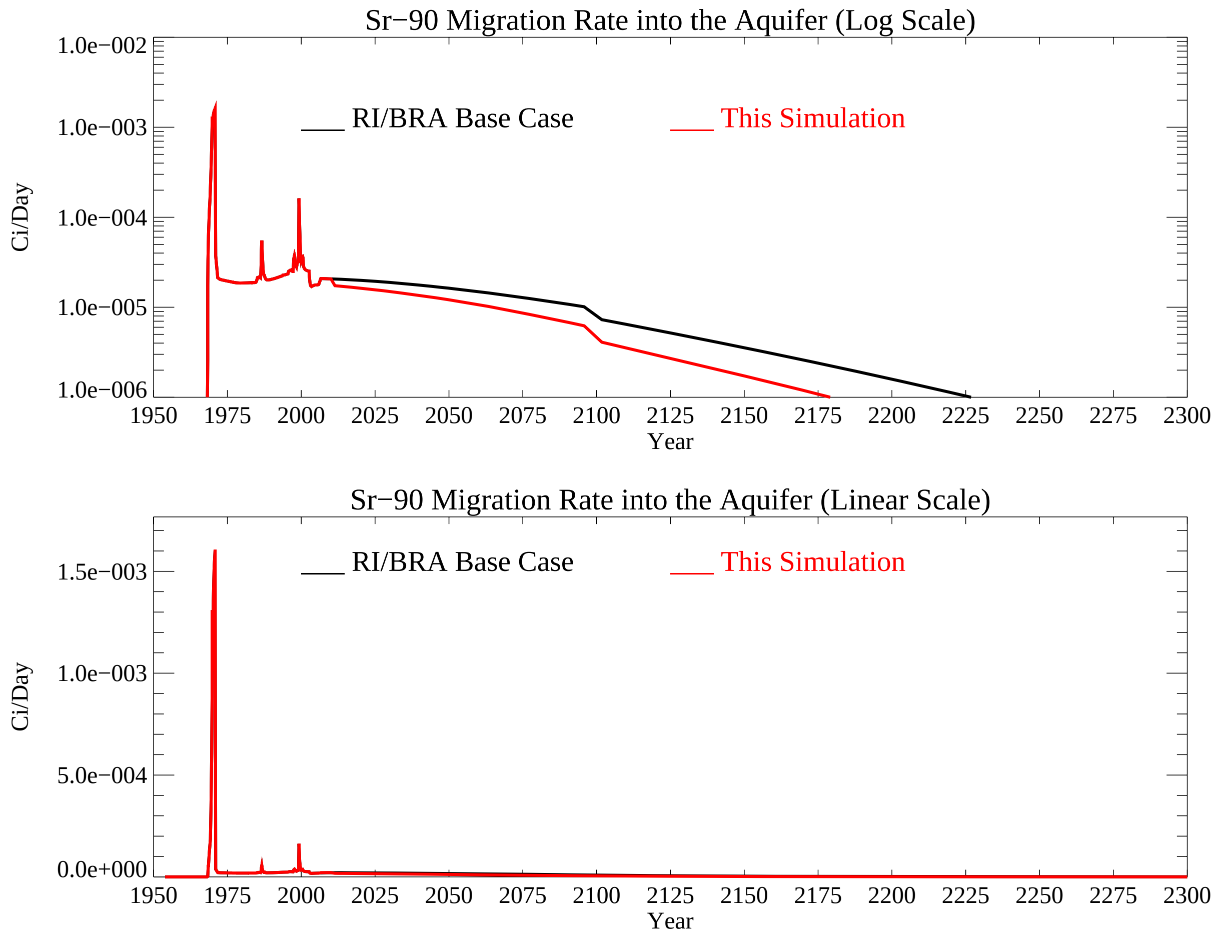


Figure A-3-8. Activity flux (Ci/day) into the aquifer after preventing infiltration from the Big Lost River.